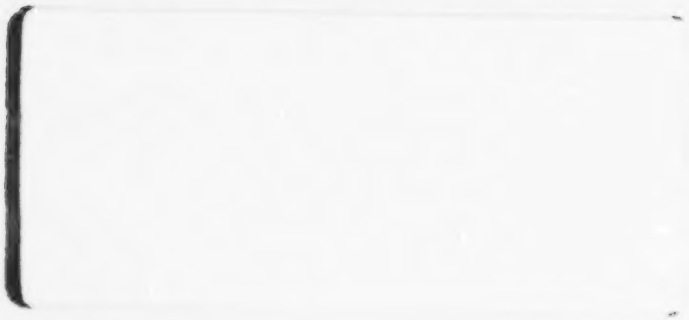

Manitoba
Environment
and Workplace
Safety and Health

MEQ-8159

# Characterization of Emissions from Ayerst Organics Ltd. Brandon, Manitoba December, 1985

by

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Air Standard and Studies
Report 86-2
February 1986

Bennett, M., 1986. Characterization of Emissions from Ayerst Organics Ltd. Brandon, Manitoba, December, 1985. Manitoba Department of Environment and Workplace Safety and Health, Air Standards and Studies Report No. 86-1. pp. 13

## Abstract

At the request of the Air Pollution Control Section of the Environmental Management Division, emission testing (air) was undertaken at Ayerst Organics Ltd. in Brandon. The main purpose of the testing was to characterize and quantify the emissions during different phases of the day-to-day operations and from two different sources. Of particular interest were ammonia ($NH_3$) and total amines as both could potentially be monitored at the ambient air quality station nearby. With an assessment of emission levels completed, computer modelling was utilized to estimate the effect that these levels might have at the station. The study concludes that emission levels are quite variable temporally with highest concentrations found midday and lowest levels at night. At all times the measured levels were very low. According to model predictions the effect of Ayerst emissions on air quality, with respect to $NH_3$ at the continuous monitoring site, would be negligible.

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## 1. BACKGROUND

The Manitoba Department of Environment and Workplace Safety and Health, within the auspices of the Impingement Program of Air Standards and Studies in the Environmental Management Division, operates an ambient air monitoring station in Brandon at Assiniboine Community College. The station was first established in September 1979 to measure various air pollutants in the area of the Brandon Industrial Park. An ammonia monitor was installed at the station in July 1982. The ammonia monitoring is performed to assess compliance by Simplot Chemical Co. Ltd. to various Clean Environment Commission Orders, the current Order being number 1080.

It has been suggested that airborne emissions from Ayerst Organics Ltd. could significantly interfere with this ambient monitoring. The Ayerst plant is located between Simplot and the Impingement monitoring station approximately 80 - 100 metres from the station.

Ayerst Organics Ltd., 720 17th Street East, Brandon, Manitoba, operates a plant for the extraction of certain conjugated estrogens from pregnant mare's urine. This material is the active ingredient in Premarin, a drug used in the treatment of certain post-menopause disorders in women. A brief description of plant processes has been documented.(1)

At the request of the Air Pollution Control Section of the Environmental Management Division, a further attempt to characterize the emissions from the plant was undertaken.(1) A preliminary survey was conducted in april of 1985. The objectives of that study included determining ambient ground level concentrations of ammonia which could be attributable to emissions from the Ayerst plant; compare these concentrations to the Manitoba Air Quality Objectives; and characterize other emission constituents. Some quantification was also performed. The specific objectives of this study were:

1) To quantify the emission level of ammonia from both the storage tanks and the main plant process.

2) To see if there was a distinguishable difference between the readings from two different types of tubes (both ammonia and total amines tubes were utilized). There is a problem with cross contamination between these two types but the respective levels of interference are not linear.

3) To estimate the impact of Ayerst emissions utilizing computer dispersion models.

## 2. EMISSION MONITORING

It should be pointed out that the method of emission monitoring employed was primarily a qualitative measurement and was used in an attempt to confirm the presence of certain suspected emissions. Some degree of quantitative measurement was made since this method uses special tubes which are are calibrated and graduated against known sources. Grab sampling was performed using a Gastec pump p/n 1G6800 and tubes (numbered below).

The glass tubes are packed with specific indicating media and hermetically sealed. The tips are broken off both ends of the tube (for use) and one end is inserted into a pump. A specified number of pump strokes (100 ml/stroke) are performed in a recommended time period prescribed for specific tube types. The ambient concentration can then be either read directly or calculated from the scale etched on the exterior of the tube. The accuracy of the method is approximately $\pm$ 25%.

The tubes indicate the presence of specific compounds on the basis of colour change reactions. The following tubes were utilized;

1) Ammonia low range tube (No. 3L)
   Measurement Range - 1-60 ppm
   Detection Principle - Ammonia neutralizes sulphuric acid to change the colour of pH indicator (Cresol red)
   Interferences - Alkyl amines or hydrazine at a concentration of more than 1/10 that of ammonia adds a positive error.[2]
2) Amines tube (No. 180)
   Measurement Range - 1-180 ppm
   Detection Principle - Amines neutralize sulphuric acid to change colour of pH indicator (Thymol blue). There is a wide variety of different amine, diamine and triamine compounds which will stimulate this reaction. With this tube it is not possible to distinguish individual amines when there is a mixture. Ammonia will also react with this tube.[2]

3. **RESULTS**

The first series of tests were conducted between 13:15-13:30 on December 4, 1985. Barometric pressure was 729 mm of mercury (Hg).

| | | | |
|---|---|---|---|
| -Main Process Vent: | | | |
| 1)$NH_3$ (low range) | 1/2 x2 pump strokes | 1 min/stroke | 17-18 ppm |
| 1)Amines | 1 pump stroke | 30 sec/stroke | >30 ppm |
| 2)$NH_3$ (low range) | 1/2 x2 pump strokes | 1 min/stroke | 20-21 ppm |
| -Storage Tank Vent: | | | |
| 3)$NH_3$ (low range) | 1/2 x2 pump strokes | 1 min/stroke | 2-3 ppm |
| 2)Amines | 1 pump stroke | 30 sec/stroke | 2-3 ppm |
| 4)$NH_3$ (low range) | 1/2 x2 pump strokes | 1 min/stroke | 3-4 ppm |

The second series of tests were conducted between 14:45-15:00 on December 4, 1985. Barometric pressure was 726 mm of Hg.

| | | | |
|---|---|---|---|
| -Main Process Vent: | | | |
| 5)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 18-19 ppm |
| 3)Amines | 1/2 pump stroke | 30 sec/stroke | 20 ppm |
| 6)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 20 ppm |
| -Storage Tank Vent: | | | |
| 7)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 5 ppm |
| 4)Amines | 1 pump stroke | 30 sec/stroke | 5 ppm |
| 8)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 4-5 ppm |

The third series of tests were conducted between 16:15-16:30 on December 4, 1985. Barometric pressure was 726 mm of Hg.

| | | | |
|---|---|---|---|
| -Main Process Vent: | | | |
| 9)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 7-8 ppm |
| 5)Amines | 1 pump stroke | 30 sec/stroke | 6-7 ppm |
| 10)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 6-7 ppm |
| -Storage Tank Vent: | | | |
| 11)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 7-8 ppm |
| 6)Amines | 1 pump stroke | 30 sec/stroke | 6-7 ppm |
| 12)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 6-7 ppm |

A fourth series of tests were conducted between 8:30-8:45 on December 5, 1985. Barometric pressure was 725 mm of Hg.

| | | | |
|---|---|---|---|
| -Main Process Vent: | | | |
| 13)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 3-4 ppm |
| 14)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 3 ppm |
| -Storage Tank Vent: | | | |
| 15)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 4-5 ppm |
| 16)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 9-10 ppm |

Notes:
-Numbers at the beginning of each line (above) represent the assigned tube numbers.
-During the fourth series of tests performed on the morning of the 5th, no amine tubes were used.

Subsequent tests were conducted once per week over the period of the next four weeks.

The first week the tests were conducted between 12:45-13:00 on December 9,1985. Barometric pressure was 730 mm of Hg.

-Main Process Vent:

| | | | |
|---|---|---|---|
| 17)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 24 ppm |
| 18)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 25 ppm |

-Storage Tank Vent:

| | | | |
|---|---|---|---|
| 19)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 9 ppm |
| 20)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 10 ppm |

During the second week the tests were conducted between 12:15 12:30 on December 20, 1985. Barometric pressure was 731 mm of Hg.

-Main Process Vent: (Emission temperature measured at 18°C.)

| | | | |
|---|---|---|---|
| 21)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 7 ppm |
| 22)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 7 ppm |

-Storage Tank Vent: (Emission temp = 17°C.)

| | | | |
|---|---|---|---|
| 23)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 4 ppm |
| 24)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 4 ppm |

In the third week the tests were conducted between 14:15-14:30 on December 23, 1985. Barometric pressure was 727 mm of Hg.

-Main Process Vent: (Emission temp. = 16°C.)

| | | | |
|---|---|---|---|
| 25)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 3 ppm |
| 26)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 4 ppm |

-Storage Tank Vent: (Emission temp. = 13°C.)

| | | | |
|---|---|---|---|
| 27)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 11 ppm |
| 28)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 11 ppm |

Fourth week tests were conducted between 14:45-15:00 on December 31, 1985. Barometric pressure was 720 mm of Hg.

-Main Process Vent: (Emission temp. = 20°C.)

| | | | |
|---|---|---|---|
| 29)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 7 ppm |
| 30)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 7 ppm |

-Storage Tank Vent: (Emission temp. = 16°C.)

| | | | |
|---|---|---|---|
| 31)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 6 ppm |
| 32)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 7 ppm |

During the fifth, and final week the tests were conducted between 12:45-13:00 on January 9, 1986. Barometric pressure was 724 mm of Hg.

| | | | |
|---|---|---|---|
| -Main Process Vent: | (Emission temp. = 19°C.) | | |
| 33)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 4 ppm |
| -Storage Tank Vent: | (Emission temp. = 16°C.) | | |
| 34)$NH_3$ (low range) | 1 pump stroke | 1 min/stroke | 9 ppm |

## 4. OBSERVATIONS

During this brief series of tests it appeared as if there was a noticeable daily variation in emission levels from the main process vent. At the time of peak production in early afternoon the level attained the measured maximum of approximately 20 ppm. It also seemed evident that there is a relatively constant low level emission rate from the storage tank vents in the range of 5 to 10 ppm.

Information provided by the plant manager at Ayerst indicates that the maximum flow rate from the main process vent is approximately 15,000 cfm (cubic feet per minute), and that the flow rates from the storage tank vents run at about 3,000 cfm. maximum. There are two storage tank vents. Therefore, a reasonable working average for plant emissions would be in the range of .00016 $m^3$/sec. of pure contaminant. In the next section reporting on the results of some preliminary dispersion modelling, the emission amount (unless otherwise noted) has been set at approximately 1.5-2 times this level to essentially represent worst-case conditions. It must be recognized then that modelling results will tend to overestimate actual concentrations or effects.

A final note, as previously mentioned, the emission testing methodology employed cannot really differentiate between $NH_3$ and some other amine compounds. It seems likely that most other amines present in the ambient air would in fact undergo conversion, similar to ammonia, in the high temperature converter of the analyzer used in the monitoring station.[3] Thus they would constitute an interference and would be recorded as ammonia.

In the results section, mention is made of barometric pressures. This is done because the manufacturer of the sampling tubes recommends that a pressure correction factor should be applied to the measured concentrations. This generally refers only to NIOSH (National Institute of Occupational Safety and Health) applications which require maximum precision. The factor for individual tests would be:

760

Atmospheric Pressure

For our purposes of dispersion modelling the application of this factor would have little net effect (approx. + 2 or 3%). Therefore, mention of the correction factor is included only for informative purposes. No correction for temperature or humidity is required.

Except for the very first test, when the amines and ammonia tubes were used concurrently, there was no significant difference in the amount measured by each. In other words the two tube types yielded approximately the same results. In the first test the amines tube indicated a much higher level than the 2 ammonia tubes. The reason for, or an explanation of this phenomenon is unknown.

## 5. DISPERSION MODELLING

Utilizing the observed emission levels from the plant some dispersion modelling was performed to see what the potential effect (concentration) would be at the ambient air monitoring station located adjacent to Assiniboine Community College. A Gaussian plume dispersion model (PLUMES), developed by the Alberta Department of Environment was used.[4] This model computes the horizontal concentration field in the height plane specified.

Several model runs were undertaken using various input parameters so as to model for a broad spectrum of atmospheric and emission situations.

The first model run (see appendix) involves essentially the worst case scenario. Basically atmospheric conditions have been used which are least likely to promote downwind dispersion. These conditions occur extremely infrequently. They are especially rare during daytime (periods of maximum plant emission) and occur mainly at night. For the modelling exercise emission levels were set at approximately 40 ppm, which is higher than the maximum measured by approximately a factor of two.

Under worst case conditions the maximum estimated concentration at our monitoring site resulting from Ayerst emissions would be approximately 0.5 ppm.

The second model run (see appendix) was the same as the first with changes to atmospheric conditions in the form of:

i) wind speed increased from 1 to 5 m/s,
ii) ambient temperature changed from 23°C to 10°C and,
iii) mixing height adjusted to 1000 m. (unlimited) from 100 m. (limited),
iv) stability class changed from F (moderately stable) to D (neutral).

These conditions closely parallel more or less average daily conditions with respect to meteorological parameters.

Under "average" atmospheric conditions the maximum estimated concentration at our monitoring site resulting from Ayerst emissions would be approximately 0.1 ppm.

The third run (see appendix) was the same as the second with a change in ambient temperature, the emission level decreased to the actual monitored level and the wind speed changed to 6 m/s. In this case the temperature was dropped from 10°C to -23°C, the condition which simulates winter conditions and closely parallel the actual ambient conditions as experienced on the day the emission monitoring took place.

Under winter conditions the maximum estimated concentration at our monitoring site resulting from Ayerst emissions would be approximately 0.04 ppm.

In the fourth and fifth runs the emission levels were adjusted to assess the effect. All of the other input variables remained the same as in the third run, with the following exceptions:

i) Run 4, wind speed decreased to 5 m/s and temperature raised to 0°C,
ii) Run 5, wind speed decreased to 1 m/s and temperature raised to 23°C.

Under constant meteorological conditions in most instances the effect that changing emission levels will have on downwind concentrations is more or less linear. Thus, if the emission level is halved the concentration at our monitoring station would drop by a factor of about 50%.

## 6. CONCLUSIONS

On the basis of the emissions testing undertaken for the preparation of this report and other testing performed previously, along with the dispersion modelling, the following conclusions are offered:

1) There appears to be a measurable change in emission concentrations related to production levels at Ayerst. This results in daily changes in the emission levels from the main process vent. Highest concentrations (approximately 20 ppm) are experienced at the height of daily production, between about 12:00 to 14:00. Levels from this vent decrease significantly at night when plant production is suspended.

2) During the production "season", from October to April each year the emission concentrations (approximately 5 - 10 ppm) from storage tank vents remain more or less constant throughout the day (24 hr.). The exact concentration is dependent upon the amount of PMU (pregnant mare's urine) in storage.

3) Emissions from either source in the summertime (non production season) are negligible.

4) Even during periods of maximum production and storage the emissions of ammonia and other amines from Ayerst are relatively insignificant and would at no time contribute appreciable interference to our ammonia analyzer at the ambient monitoring station. Dispersion estimates predict that the influence of Ayerst emissions would be approximately 1/10th of 1 ppm.

5) Amine and ammonia tubes may be used interchangeably to determine the concentration of specific nitrogenous compounds which can be detected by the ambient ammonia analyzer.

## 7. REFERENCES

1) Szkolnicki, M. and M. Bennett, 1985. Preliminary Survey - Characterization of Emissions from Ayerst Organics Ltd. Brandon, Manitoba. Manitoba Department of Environment and Workplace Safety and Health, Air Standards and Studies Report No. 85-8. pp. 19.

2) Gas Precision Gas Detector System - Blue Book, 1982. Gastec Corporation, Tokyo, Japan.

3) Regehr, D., 1985. Ammonia-in-Air Levels in the Vicinity of the Brandon Industrial Park, Brandon, Manitoba, Report No. 3 November 1983 to May 1985. Manitoba Department of Environment and Workplace Safety and Health, Air Standards and Studies Report No. 85-6. pp.38.

4) Alberta Environment, 1980. Guidelines for Plume Dispersion Calculations, 2nd Edition. Standards and Approvals Division. pp. 112.

# APPENDIX

This is a file of input parameters for Ayerst Organics.

```
        WIND SPEED =     1.  M/S
    WIND DIRECTION =   120.  DEGREES FROM TRUE NORTH
  ANEMOMETER HEIGHT =    10.  M

AMBIENT TEMPERATURE =    23.  C

FLAT TERRAIN
ROUGHNESS = 100 CM

INVERSION BREAKUP (HEWSON FUMIGATION)
TEMPERATURE GRADIENT THROUGH INVERSION =  .000  K/M

PASQUILL STABILITY CATEGORY F /MODERATELY STABLE


DOWNWIND DISTANCES
          MAXIMUM =   200.  M
          MINIMUM =     0.  M
        INCREMENT =    20.  M

CROSSWIND DISTANCES
          MAXIMUM =   100.  M
          MINIMUM =  -100.  M
        INCREMENT =    20.  M


   NUMBER OF STACKS =   1


PARAMETERS FOR STACK  1

        STACK HEIGHT =     8.  M
      STACK DIAMETER =    .50  M
      STACK DISTANCE =     0.  M  FROM ORIGIN
         STACK ANGLE =     0.  DEGREES FROM TRUE NORTH
        GAS VELOCITY =     1.  M/S
     GAS TEMPERATURE =    23.  C
       EMISSION RATE = .000300  M**3/S AT 101.325 KPA AND REFERENCE TEMPERATURE
REFERENCE TEMPERATURE =    10.0 C
          X RELATIVE =     0.  M
          Y RELATIVE =     0.  M

***** STACK AERODYNAMIC DOWNWASH OCCURS UNDER THE SPECIFIED ATMOSPHERIC CONDITIONS *****
```

CUMULATIVE POLLUTANT CONCENTRATION IN PPM AS A 1.00 HOUR AVERAGE AT A HEIGHT OF 5. M ABOVE THE GROUND

| CROSSWIND DISTANCE (M) | DOWNWIND DISTANCE IN METERS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 |
| 100 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 80 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 |
| 60 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .003 | .005 | .007 |
| 40 | .000 | .000 | .000 | .001 | .004 | .011 | .018 | .026 | .034 | .040 | .045 |
| 20 | .000 | .027 | .083 | .128 | .154 | .164 | .165 | .160 | .153 | .145 | .136 |
| 0 | .000 | 1.324 | .875 | .644 | .503 | .409 | .342 | .292 | .253 | .222 | .197 |
| -20 | .000 | .027 | .083 | .128 | .154 | .164 | .165 | .160 | .153 | .145 | .136 |
| -40 | .000 | .000 | .000 | .001 | .004 | .011 | .018 | .026 | .034 | .040 | .045 |
| -60 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .003 | .005 | .007 |
| -80 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 |
| -100 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |

MAXIMUM CONCENTRATION IN THE ABOVE TABLE IS 1.324 PPM AND OCCURS AT ( 20 , 0 )

| STACK | EFFECTIVE STACK HEIGHTS IN METRES AT ABOVE DOWNWIND DISTANCES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1********* | 10. | 10. | 10. | 10. | 10. | 10. | 10. | 10. | 10. | 10. |

A>

This is a file of input parameters for Ayerst Organics

```
        WIND SPEED =      5.  M/S
    WIND DIRECTION =    120.  DEGREES FROM TRUE NORTH
  ANEMOMETER HEIGHT =     10.  M

AMBIENT TEMPERATURE =     10.  C

FLAT TERRAIN
ROUGHNESS = 100 CM

ELEVATED INVERSION BASED AT   1000.  M
TEMPERATURE GRADIENT THROUGH INVERSION =  .000  K/M

PASQUILL STABILITY CATEGORY D /NEUTRAL


DOWNWIND DISTANCES
          MAXIMUM =    200.  M
          MINIMUM =      0.  M
        INCREMENT =     20.  M

CROSSWIND DISTANCES
          MAXIMUM =    100.  M
          MINIMUM =   -100.  M
        INCREMENT =     20.  M


   NUMBER OF STACKS =    1


PARAMETERS FOR STACK  1

         STACK HEIGHT =      8.  M
       STACK DIAMETER =     .50  M
       STACK DISTANCE =      0.  M  FROM ORIGIN
          STACK ANGLE =      0.  DEGREES FROM TRUE NORTH
         GAS VELOCITY =      1.  M/S
      GAS TEMPERATURE =     23.  C
        EMISSION RATE = .000300  M**3/S AT 101.325 KPA AND REFERENCE TEMPERATURE
 REFERENCE TEMPERATURE =    10.0  C
            X RELATIVE =      0.  M
            Y RELATIVE =      0.  M

***** STACK AERODYNAMIC DOWNWASH OCCURS UNDER THE SPECIFIED ATMOSPHERIC CONDITIONS *****
```

CUMULATIVE POLLUTANT CONCENTRATION IN PPM AS A 1.00 HOUR AVERAGE AT A HEIGHT OF 5. M ABOVE THE GROUND

| CROSSWIND DISTANCE (M) | DOWNWIND DISTANCE IN METERS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 |
| 100 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 |
| 80 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .001 | .002 | .003 |
| 60 | .000 | .000 | .000 | .000 | .000 | .001 | .002 | .004 | .006 | .007 | .007 |
| 40 | .000 | .000 | .000 | .001 | .005 | .010 | .014 | .016 | .017 | .016 | .015 |
| 20 | .000 | .000 | .018 | .041 | .047 | .046 | .042 | .036 | .032 | .027 | .023 |
| 0 | .000 | .521 | .216 | .136 | .098 | .075 | .059 | .047 | .039 | .032 | .027 |
| -20 | .000 | .000 | .018 | .041 | .047 | .046 | .042 | .036 | .032 | .027 | .023 |
| -40 | .000 | .000 | .000 | .001 | .005 | .010 | .014 | .016 | .017 | .016 | .015 |
| -60 | .000 | .000 | .000 | .000 | .000 | .001 | .002 | .004 | .006 | .007 | .007 |
| -80 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .001 | .002 | .003 |
| -100 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 |

MAXIMUM CONCENTRATION IN THE ABOVE TABLE IS .521 PPM AND OCCURS AT ( 20 , 0 )

| STACK | EFFECTIVE STACK HEIGHTS IN METRES AT ABOVE DOWNWIND DISTANCES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1********* | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. |

A>

This is a file of input parameters for Ayerst Organics

```
        WIND SPEED =      6.  M/S
    WIND DIRECTION =    120.  DEGREES FROM TRUE NORTH
  ANEMOMETER HEIGHT =     10.  M

AMBIENT TEMPERATURE =    -23.  C

FLAT TERRAIN
ROUGHNESS = 100 CM

ELEVATED INVERSION BASED AT    100.  M
TEMPERATURE GRADIENT THROUGH INVERSION =  .000  K/M

PASQUILL STABILITY CATEGORY D /NEUTRAL


DOWNWIND DISTANCES
           MAXIMUM =    200.  M
           MINIMUM =      0.  M
         INCREMENT =     20.  M

CROSSWIND DISTANCES
           MAXIMUM =    100.  M
           MINIMUM =   -100.  M
         INCREMENT =     20.  M


   NUMBER OF STACKS =    1


PARAMETERS FOR STACK  1

        STACK HEIGHT =      8.  M
       STACK DIAMETER =     .50  M
       STACK DISTANCE =      0.  M  FROM ORIGIN
         STACK ANGLE =      0.  DEGREES FROM TRUE NORTH
        GAS VELOCITY =      1.  M/S
      GAS TEMPERATURE =     23.  C
       EMISSION RATE = .000200  M**3/S AT 101.325 KPA AND REFERENCE TEMPERATURE
 REFERENCE TEMPERATURE =    10.0  C
           X RELATIVE =      0.  M
           Y RELATIVE =      0.  M


    ***** STACK AERODYNAMIC DOWNWASH OCCURS UNDER THE SPECIFIED ATMOSPHERIC CONDITIONS *****
```

CUMULATIVE POLLUTANT CONCENTRATION IN PPM AS A 1.00 HOUR AVERAGE AT A HEIGHT OF 5. M ABOVE THE GROUND

| CROSSWIND DISTANCE (M) | DOWNWIND DISTANCE IN METERS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 |
| 100 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 80 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .001 | .001 |
| 60 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .002 | .003 | .003 | .004 |
| 40 | .000 | .000 | .000 | .001 | .003 | .005 | .007 | .008 | .008 | .008 | .007 |
| 20 | .000 | .000 | .009 | .019 | .023 | .022 | .020 | .017 | .015 | .013 | .011 |
| 0 | .000 | .242 | .103 | .065 | .047 | .036 | .029 | .023 | .019 | .016 | .013 |
| -20 | .000 | .000 | .009 | .019 | .023 | .022 | .020 | .017 | .015 | .013 | .011 |
| -40 | .000 | .000 | .000 | .001 | .003 | .005 | .007 | .008 | .008 | .008 | .007 |
| -60 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .002 | .003 | .003 | .004 |
| -80 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .001 | .001 |
| -100 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |

MAXIMUM CONCENTRATION IN THE ABOVE TABLE IS .242 PPM AND OCCURS AT ( 20 , 0 )

| STACK | EFFECTIVE STACK HEIGHTS IN METRES AT ABOVE DOWNWIND DISTANCES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1********** | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. |

A>

This is a file of input parameters for Ayerst Organics

| | | |
|---|---|---|
| WIND SPEED = | 5. | M/S |
| WIND DIRECTION = | 120. | DEGREES FROM TRUE NORTH |
| ANEMOMETER HEIGHT = | 10. | M |
| AMBIENT TEMPERATURE = | 0. | C |

FLAT TERRAIN
ROUGHNESS = 100 CM

UNLIMITED MIXING

PASQUILL STABILITY CATEGORY D /NEUTRAL

DOWNWIND DISTANCES

| | | |
|---|---|---|
| MAXIMUM = | 200. | M |
| MINIMUM = | 0. | M |
| INCREMENT = | 20. | M |

CROSSWIND DISTANCES

| | | |
|---|---|---|
| MAXIMUM = | 100. | M |
| MINIMUM = | -100. | M |
| INCREMENT = | 20. | M |

NUMBER OF STACKS = 1

PARAMETERS FOR STACK 1

| | | |
|---|---|---|
| STACK HEIGHT = | 8. | M |
| STACK DIAMETER = | .50 | M |
| STACK DISTANCE = | 0. | M FROM ORIGIN |
| STACK ANGLE = | 0. | DEGREES FROM TRUE NORTH |
| GAS VELOCITY = | 1. | M/S |
| GAS TEMPERATURE = | 23. | C |
| EMISSION RATE = | .000200 | M**3/S AT 101.325 KPA AND REFERENCE TEMPERATURE |
| REFERENCE TEMPERATURE = | 10.0 | C |
| X RELATIVE = | 0. | M |
| Y RELATIVE = | 0. | M |

***** STACK AERODYNAMIC DOWNWASH OCCURS UNDER THE SPECIFIED ATMOSPHERIC CONDITIONS *****

CUMULATIVE POLLUTANT CONCENTRATION IN PPM AS A 1.00 HOUR AVERAGE AT A HEIGHT OF 5. M ABOVE THE GROUND

| CROSSWIND DISTANCE (M) | DOWNWIND DISTANCE IN METERS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 |
| 100 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 80 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .001 | .002 |
| 60 | .000 | .000 | .000 | .000 | .000 | .001 | .002 | .003 | .004 | .004 | .005 |
| 40 | .000 | .000 | .000 | .001 | .003 | .007 | .009 | .010 | .011 | .010 | .010 |
| 20 | .000 | .000 | .012 | .026 | .030 | .029 | .027 | .023 | .020 | .017 | .015 |
| 0 | .000 | .327 | .137 | .086 | .062 | .048 | .038 | .030 | .025 | .021 | .017 |
| -20 | .000 | .000 | .012 | .026 | .030 | .029 | .027 | .023 | .020 | .017 | .015 |
| -40 | .000 | .000 | .000 | .001 | .003 | .007 | .009 | .010 | .011 | .010 | .010 |
| -60 | .000 | .000 | .000 | .000 | .000 | .001 | .002 | .003 | .004 | .004 | .005 |
| -80 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .001 | .002 |
| -100 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |

MAXIMUM CONCENTRATION IN THE ABOVE TABLE IS .327 PPM AND OCCURS AT ( 20 , 0 )

| STACK | EFFECTIVE STACK HEIGHTS IN METRES AT ABOVE DOWNWIND DISTANCES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ********* | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. | 7. |

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This is a file of input parameters for Ayerst Organics

```
        WIND SPEED =     1.  M/S
    WIND DIRECTION =   120.  DEGREES FROM TRUE NORTH
  ANEMOMETER HEIGHT =    10.  M

AMBIENT TEMPERATURE =    23.  C

FLAT TERRAIN
ROUGHNESS = 100 CM

INVERSION BREAKUP (HEWSON FUMIGATION)
TEMPERATURE GRADIENT THROUGH INVERSION =  .000  K/M

PASQUILL STABILITY CATEGORY F /MODERATELY STABLE


DOWNWIND DISTANCES
          MAXIMUM =   200.  M
          MINIMUM =     0.  M
        INCREMENT =    20.  M

CROSSWIND DISTANCES
          MAXIMUM =   100.  M
          MINIMUM =  -100.  M
        INCREMENT =    20.  M


  NUMBER OF STACKS =   1


PARAMETERS FOR STACK  1

        STACK HEIGHT =     8.  M
      STACK DIAMETER =   .50  M
      STACK DISTANCE =     0.  M  FROM ORIGIN
         STACK ANGLE =     0.  DEGREES FROM TRUE NORTH
        GAS VELOCITY =     1.  M/S
     GAS TEMPERATURE =    23.  C
       EMISSION RATE = .000600  M**3/S AT 101.325 KPA AND REFERENCE TEMPERATURE
REFERENCE TEMPERATURE =  10.0  C
          X RELATIVE =     0.  M
          Y RELATIVE =     0.  M


***** STACK AERODYNAMIC DOWNWASH OCCURS UNDER THE SPECIFIED ATMOSPHERIC CONDITIONS *****
```

CUMULATIVE POLLUTANT CONCENTRATION IN PPM AS A 1.00 HOUR AVERAGE AT A HEIGHT OF 5. M ABOVE THE GROUND

| CROSSWIND DISTANCE (M) | DOWNWIND DISTANCE IN METERS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 |
| 100 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 80 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 |
| 60 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .003 | .005 | .009 | .014 |
| 40 | .000 | .000 | .000 | .002 | .009 | .021 | .037 | .053 | .068 | .080 | .090 |
| 20 | .000 | .053 | .165 | .257 | .308 | .328 | .329 | .320 | .306 | .290 | .273 |
| 0 | .000 | 2.647 | 1.750 | 1.288 | 1.007 | .818 | .684 | .583 | .506 | .444 | .395 |
| -20 | .000 | .053 | .165 | .257 | .308 | .328 | .329 | .320 | .306 | .290 | .273 |
| -40 | .000 | .000 | .000 | .002 | .009 | .021 | .037 | .053 | .068 | .080 | .090 |
| -60 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .003 | .005 | .009 | .014 |
| -80 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 |
| -100 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |

MAXIMUM CONCENTRATION IN THE ABOVE TABLE IS 2.647 PPM AND OCCURS AT ( 20 , 0 )

| STACK | EFFECTIVE STACK HEIGHTS IN METRES AT ABOVE DOWNWIND DISTANCES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1********* | 10. | 10. | 10. | 10. | 10. | 10. | 10. | 10. | 10. | 10. |